

# Watershed Analysis Manual

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# Acknowledgments

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The manual production was supervised by TFW's Cooperative Monitoring Evaluation and Research Committee (CMER) under the guidance of the TFW Policy Group and the Forest Practices Board. The current manual represents work in progress on a complex issue completed under a statutory timetable. Further revision of the manual and methods are required to maintain the technical viability and credibility of the procedures it contains. Periodic revision and incorporation of new methods and insight is a fundamental assumption of the diagnostic approach upon which this manual relies.

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# Introduction to Watershed Analysis

## Background

The 1974 Forest Practices Act provides authority for state regulation of forest practices on Washington's 12.5 million acres of state and private lands. Regulations are primarily designed to protect public resources by preventing erosion from roads, to protect water quality and provide fish and wildlife habitat with streamside buffers, to protect wetlands and to ensure long-term supply of forests with reforestation requirements. Since 1974, significant changes have been made in the rules, reflecting improved scientific knowledge and efforts to promote efficient regulation and effective resource protection while ensuring industry stability.

Until the cumulative effects rules were adopted, forest practices were considered one activity at a time. Although the regulations provide protection on a site by site basis, there are concerns that the watershed as a whole may be affected by the "cumulative effects" of all of the activities in the basin. Cumulative effects have been defined as "the changes to the environment caused by the interaction of natural ecosystem processes with the effects of two or more forest practices." These changes may be taken to include effects on water quality, wildlife, fish habitat, and other public resources.

Although it is desirable to consider watersheds as a whole in regulations of forest practices, there are practical and conceptual difficulties in doing so. These arise from several sources:

1. Watershed ecosystems involve a complex dynamic between many watershed and biological processes operating at many spatial scales. Scientific understanding of these processes is limited, and comprehensive reliable techniques for evaluating watersheds are lacking.
2. The physical and biological characteristics of a watershed and sub-areas within it reflect the local geology, terrain, climate, vegetation and so on. Consequently, every watershed is unique, with its own distribution of these factors as well as effects due to the history of past disturbance including natural events or land use.

3. Because of these differences in landscape features, the sensitivity of watersheds and sub-areas within them to forest practices also varies from place to place. While one location may generate no likelihood of local or cumulative effects from an activity, the same activity conducted in the same way in another location with heightened sensitivity could have both local and cumulative impacts.

For all of these reasons, there appears to be no simple method that can be uniformly applied to watersheds throughout the state to reliably guide management activities at the basin scale to prevent cumulative effects. When evaluating forest activities one-by-one, it is difficult to adequately weigh all the possible effects of an activity for the entire watershed. Even though local site conditions are taken into account when conditioning forest practices applications for a site, the “one-size-fits-all” approach of forest rules based on “best management practices” that formed the basis for the forest practice regulatory process is not well suited to tailoring practices to local basin-wide situations as needed.

## Recent History of Cumulative Effects Leading To A Policy Framework

In recent years, efforts have been initiated to review regulations to ensure more systematic treatment of cumulative effects.

The Timber/Fish/Wildlife (TFW) Agreement concluded in February of 1987, contained the following summary of a recommended approach to cumulative effects:

1. State, regional, and basin goal-setting. Goals and objectives should be developed that reflect local conditions and resource sensitivities. Participants should include TFW cooperators, such as tribes, landowners, and environmental groups.
2. Use of risk assessment techniques for problem identification. Methods and techniques should support the setting of goals and objectives. They should anticipate or predict future problems as well as define existing ones.

3. Implementation of an adaptive management process in which assessment tools, management and regulation are revised based upon experience and the feedback from monitoring.
4. Monitoring and evaluation to determine if goals are being met. Monitoring programs should be developed that are tailored to regional and local landscape variability.
5. Reevaluation of goals as new information becomes available.

In 1989, the TFW Policy Group approved a cumulative effects issue paper that recommended development of a system which would focus on individual basins. Problems assessment would address spatial and temporal issues, with efforts to define impact thresholds and recovery rates for affected resources. The report went on to reinforce the role of the Cooperative Monitoring Evaluation and Research (CMER) Committee in providing the tools needed for addressing cumulative effects. CMER is composed of resource scientists with a number of technical disciplines who represent agencies, landowners, tribes and environmental groups. Their responsibility is to guide the development and application of TFW-sponsored research to improve forest management. In response to the specific recommendations from the policy group, CMER began working on a method that would provide a science-based approach for assessing watershed problems and sensitivities to be used as a basis for developing appropriate prescriptions.

The Sustainable Forestry Roundtable, which met periodically from 1989 through most of 1990, built the concepts on which CMER was working into the proposals that it considered. Even though the negotiations resulted in neither an agreement nor legislation, they did form an important point of reference for later consideration.

In 1991, proposed changes in the state forest practices rules drew upon these efforts, calling for the Department of Natural Resources (DNR) to continue work with CMER in developing a method for use in conditioning proposed forest practices for cumulative effects. The result of the work involving scientists and policy-makers was a recommendation that the Forest Practices Board adopt a process for developing a watershed forest practices plan tailored to each watershed based on scientific understanding. They termed the process "watershed analysis". The method defines areas of sensitivity within each watershed with explicit consideration of resource vulnerabilities based on the potential for specific impacts to public resources. This method was adopted by the Forest Practices Board into regulation in 1992 (WAC 222-22). (The Forest Practices Board decided not to include wildlife in the current watershed analysis rules.) Watershed analysis is a principle but not an exclusive section of the forest practice rules that addresses cumulative watershed effects.

As part of the watershed analysis rule, the state has been divided into approximately 800 watersheds ranging in size of approximately 10,000 to 50,000 acres. These watersheds are termed Watershed Administrative Units (WAUs). Their boundaries can be found on the DNR Watershed Administrative Unit Map.



# The Washington Approach to Forest Watershed Management—Watershed Analysis

Watershed analysis is a structured approach to developing a forest practices plan for a WAU based on a biological and physical inventory. It is a collaborative process involving resource scientists and managers representing land-owners, agencies, tribes and other interested public. Once initiated, the team conducts the assessment within a specific time- frame. (See figure I-1). The forest practices rules provide a policy structure to the process by encoding the steps, operating rules, key linkages and decision requirements for the team. This manual guides the specific technical steps of the process in support of the policy laid out in the rule. The application of the process is expected to evolve as scientific knowledge and experience with the process grows, and those improvements will be included in future versions of the Watershed Analysis Manual. The watershed analysis process can best be viewed as a work in progress.

## Components of Watershed Analysis

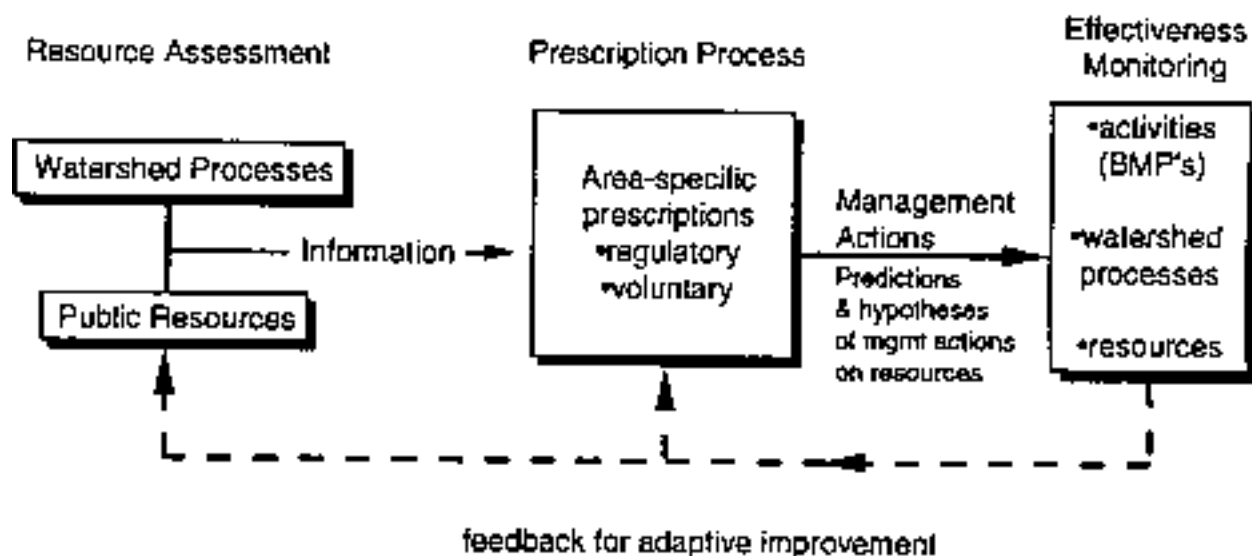


Figure I-1 The Major Components of Watershed Analysis

In watershed analysis, the scientists first develop information and interpretations of resource conditions and sensitivities at a watershed scale guided by a series of key questions. These findings include maps locating sensitive areas (which may include all or parts of the watershed) and reports describing the nature of the sensitivity and its risk to public resources supported with facts and data generated by the team. These then feed into a prescription process where local land managers and agencies develop a tailored management plan for the watershed that responds to the resource concerns identified by scientific investigation. Provisions are made for the public review of the findings of the watershed study and management prescriptions before final acceptance of the plan. Total time to completion is two to five months depending on the size and complexity of the watershed and the chosen level of assessment.

Once the watershed plan is developed, further forestry activities in the watershed must be conducted within the provisions of the watershed analysis prescriptions for each sensitive area, unless an alternative plan is approved, with compliance regulated by the DNR. Products of the watershed analysis are assumed to be valid for a period of five years, at which time the process may be repeated if necessary.

The watershed plan is designed to be adaptive. Provisions are included for design of an optional monitoring plan to be implemented by landowners, agencies, tribes, and others interested in the watershed to track the effectiveness of the prescriptions and the assessments on which they were based. Monitoring is designed to provide feedback on where resources were actually protected or improving as a result of prescriptions.

By encoding into regulations a science-based assessment process rather than a one-size-fits-all set of "Best Management Practices (BMPs)", the watershed analysis process represents a departure from conventional approaches to forest land regulation. The new system not only requires local scientific assessments but relies upon diligent revision as monitoring provides feedback on whether resources are improving or degrading. It also relies on stakeholders within each watershed to make it work.

Some of the important features of the watershed analysis process for regulating forest practices on state and private lands include:

- A recognition that watersheds are different and effects of forest practices are not uniform. Therefore, watershed information is required as part of the process for generating watershed prescriptions.
- Watershed activities are prescribed based on information generated by qualified scientists defining the watershed conditions.

- The plan containing a comprehensive set of prescriptions designed with respect to the landscape is constructed by qualified managers with provisions encouraging all stakeholders to participate in the process.
- The managers and scientists work together on the geography to conduct a watershed analysis.

# Overview of the Scientific Framework and Assumptions

A basic premise of the watershed analysis is that a change in erosion, hydrology, or riparian function resulting from forest practices is significant when it is sufficient to cause an adverse change in a public resource of fish habitat, water quality, or public works. To adequately relate changes in watershed processes (sources or “causes”) to effects on public resources they must be linked. Hillslope processes are linked to stream-related resources by the flow of geomorphic products of sediment, water, wood, and energy that shape and determine the stream environment. This linkage is depicted in Figure I-2.

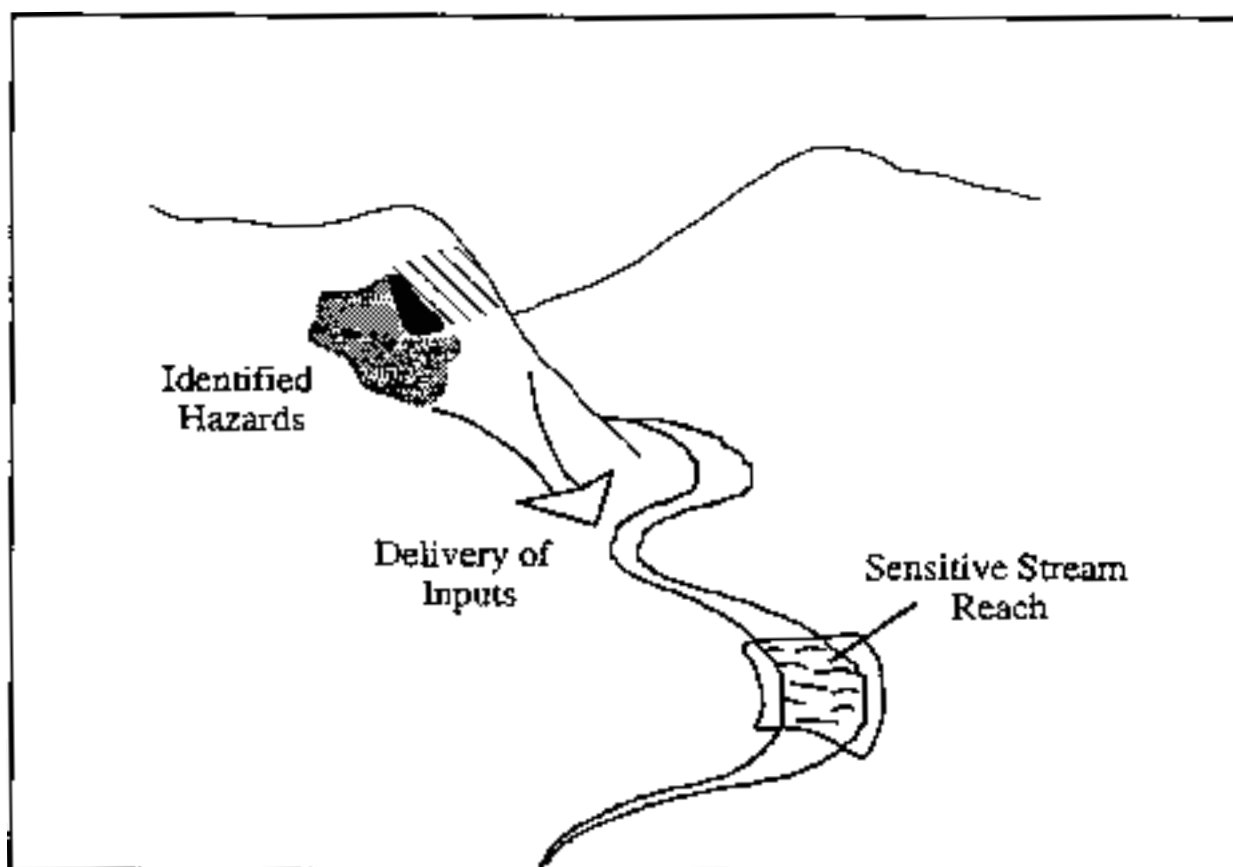


Figure I-2. Watershed analysis perspective of the spatial relationship between hillslope activities and stream effects through changes in input factors of sediment, water, wood or energy.

Forest practices may affect the amount of geomorphic products produced and delivered to streams in an area (i.e., increased erosion, changes in water available for runoff, altering wood loading to streams, or changing the temperature of water by removing shade). The mechanisms determining the effect of forest practices on the rate of input of geomorphic inputs are relatively well understood and approaches for assessing them are straightforward. Since each watershed possesses distinct environmental conditions, resource characteristics, and sensitivities, watershed analysis assessment is premised on the need to define locally active watershed processes that pose a significant risk to public resources. Each of these general processes includes more specific processes, and those addressed explicitly in the current version of watershed analysis are shown in Figure I-3.

Changes in geomorphic inputs, if large enough, may express themselves in stream channels in measurable ways. In turn, these changes in the physical characteristics of streams as they respond to sediment, water, wood and energy may have impacts on the biologic communities inhabiting them or public works located on or near them. Streams and associated resources such as fish habitat may be affected by changes in peak flows and timing of discharge. Higher sediment loading, arising from erosion and mass wasting, may cause pool filling or gravel siltation which may reduce the productive potential of a stream or stream segment. Reductions in large organic debris (LOD) recruited to channels may result in fewer pools and unstable stream beds. Other cumulative watershed effects include changes in stream temperature, nutrient levels and turbidity.

Although mechanisms for response are reasonably well understood, methods for correlating the extent of response of channels and biologic communities to changes in geomorphic factors are not well developed. For determination of impact potential or risk, a link must be made between the resource and a mechanism that can affect it. The procedure provides for this by defining resource vulnerability in terms of a specific susceptibility to change in flows of wood, water, energy, and sediment and the susceptibility is related to the manner in which resource functions respond to changes in physical conditions.

While individual models exist for assessing specific processes, no “off-the-shelf” method is available that comprehensively links hillslope processes to resource impacts at a watershed scale. This reflects the inherent complexity of the many processes at work in the forest landscape as well as the immaturity of several of the scientific disciplines. Because of these deficiencies, individual methods and models must be linked in less comprehensive, less quantitative fashion.

## Processes, Variables, and Resources Addressed in Watershed Analysis

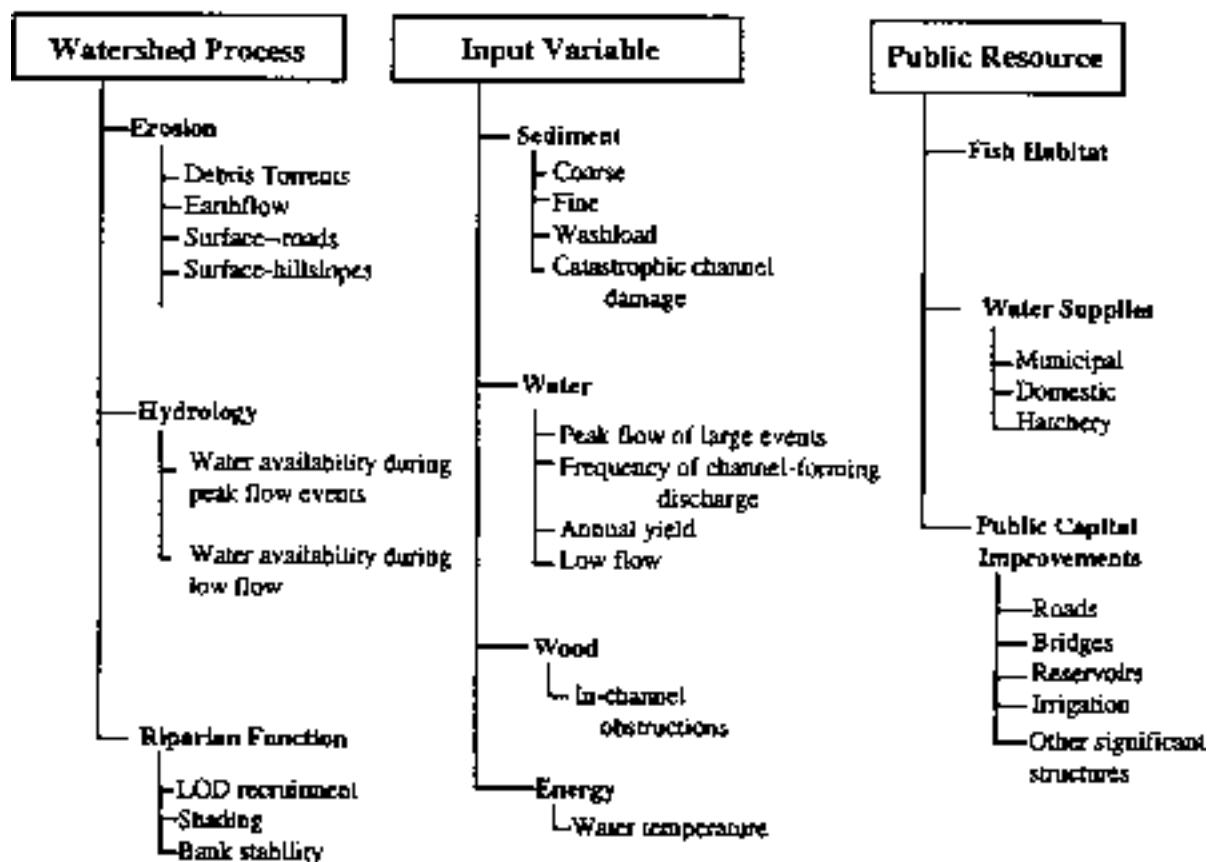


Figure I-3. Processes, Variables and Resources Addressed in Watershed Analysis

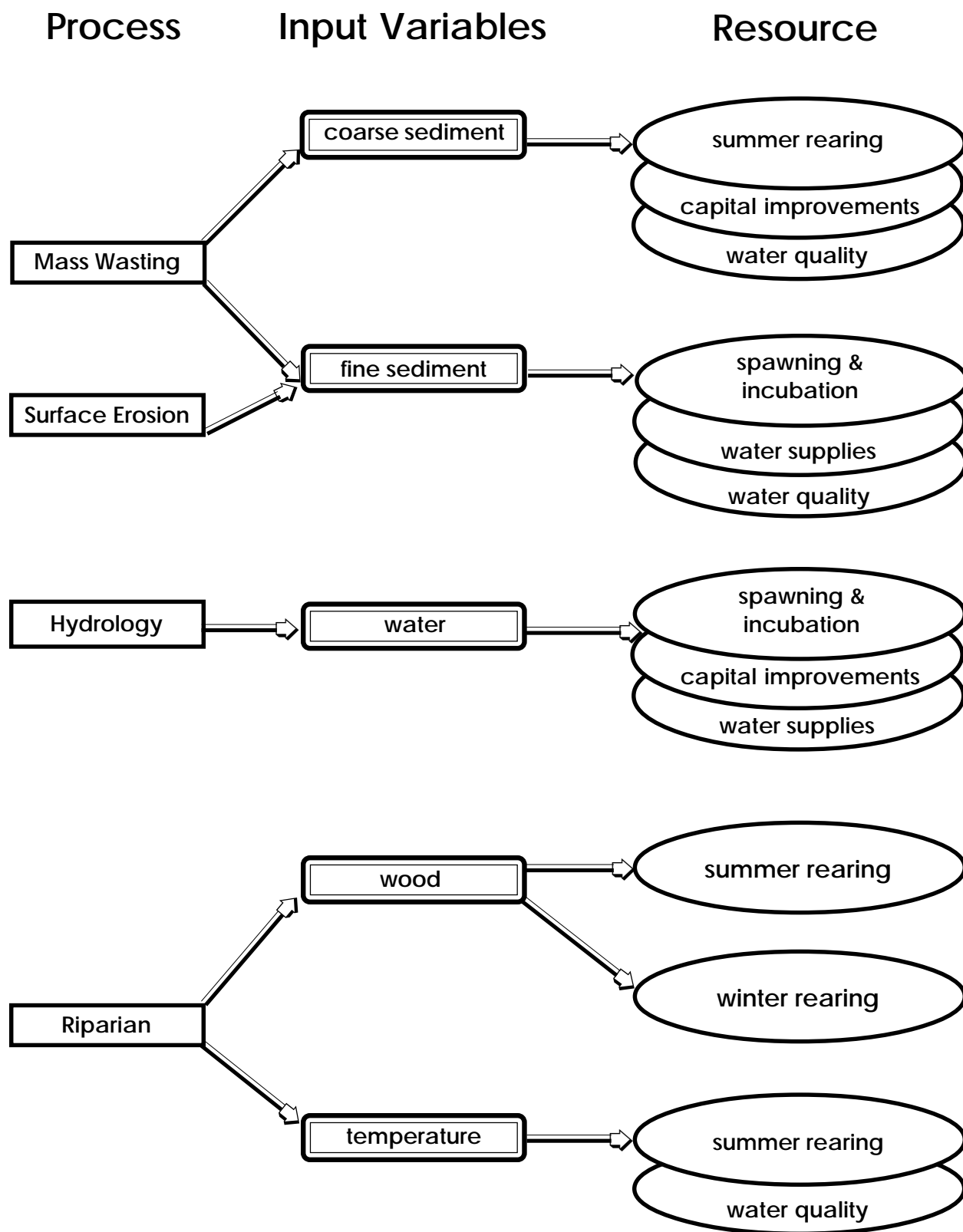


Figure I-4. Relationships among watershed processes, input variables, and effects on public resources.

# Overview of the Operational Approach to Watershed Analysis

Cumulative effects may occur in two ways. Cumulative effects may result from the accumulation of the small effects of many forest practices that are insignificant at any one site, including practices conducted over time or space. This mechanism of cumulative effects may be most relevant for hydrologic changes and for some aspects of erosion from forest roads and streamside buffers. Cumulative effects may also result from changes in dominant watershed processes, even when activities triggering effects are limited in spatial extent. This mechanism is operative in “sensitive areas” where watershed processes are particularly susceptible to change based on the local conditions. Cumulative effects are most likely for sensitive areas dominated by mass wasting, hillslope surface erosion, and some aspects of forest roads and streamside riparian zones.

A fundamental assumption of watershed analysis is that by applying standard forest practices in less sensitive areas and managing sensitive areas appropriately, the overall watershed condition will be protected and cumulative effects will not occur. The mission of the scientific assessment is to identify sensitive areas, which may include the entire watershed or sub-areas within it. (An area may be sensitive to a type or a rate of activity, and both are examined in watershed analysis.) Resource specialists gather information and interpret watershed processes and conditions. This information is used to identify resource sensitivities that require special management prescriptions to solve potential or existing problems not normally handled by standard forest practices. An assumption of watershed analysis is that resource sensitivities can be identified by qualified individuals at a scale appropriate for developing a sound watershed plan.

Once sensitivities are identified the field managers team develops prescriptions for the area with the justification that they are likely to solve the identified problem. An assumption of watershed analysis is that management plans should be developed by those with the skills and experience to conduct forest management activities. In addition, those with the responsibility to implement prescriptions should be involved in their development. It is a fundamental philosophy of the process that the best solutions will result when the scientists that develop the information for a geography work collaboratively with the resource managers responsible for developing and implementing the plan for the area.



# Overview of the Watershed Analysis Team Process

Once a watershed analysis is started, the team process progresses through a series of steps beginning with resource assessment, followed by prescription writing, and concluding with wrap-up steps that assure a handoff of responsibilities for monitoring and voluntary activities to stakeholders in the watershed. This manual provides instructions and guidelines on how to perform each step of watershed analysis.

## Startup

Watershed analysis is initiated with startup. In this step, the maps, photographs and data are collected. The various teams are formed, responsibilities are defined, and notifications are distributed. The resource assessment team also develops a plan for performing the required evaluations of the watershed.

## Resource Assessment

The resource assessment takes an interdisciplinary team approach that requires inventories of watershed processes and resources following a structured approach to problem definition that is framed by a series of critical questions. Team members possessing skills in forestry, forest hydrology, fisheries, forest soils science or geology, and geomorphology locate and map sensitive areas, evaluate potential impacts of delivery, and assess the potential or existing impacts on resources. The inventories and subsequent interpretations provide a basis for area-specific problem statements and rule calls linking forest practices, watershed processes, and resource effects.

## Prescription Process

Based on the findings of the resource assessment, a field managers team made up of managers and analysts determines the required and voluntary forest practices for each identified area of resource assessment. Managers and resource specialists visit the sensitive areas and identify one or more practices or strategies for each that are likely to prevent, avoid, or minimize problems. Problems associated with non-forest activities are referred to the appropriate agency. Prescriptions are included in the watershed analysis report. The report is provided to the Department of Natural Resources, which manages the public review.

## Wrap-up

Once the watershed analysis report is complete, the watershed analysis team may perform one last task - develop a plan to measure the effectiveness of the prescriptions. The group identifies appropriate monitoring variables and protocols to test the effectiveness of the plan using the information gathered in the assessments as a basis. These will depend on (1) the findings of the watershed analysis, (2) the variables most useful for determining whether long-term resource goals are met, and (3) the financial and personnel resources available. Two steps are useful: a prognosis step, in which the team hypothesizes their expectation of likely future conditions, given management prescriptions; and a monitoring selection step, in which specific characteristics are selected for tracking whether those expectations are met. These are passed on to stakeholders in the watershed for implementation.

# Watershed Analysis Products

The watershed analysis team produces a number of products during the assessment. The resource specialists produce:

- Resource condition reports describing watershed conditions;
- Maps of sensitive areas requiring prescriptions;
- Causal Mechanism reports describing the sensitive area and the nature of potential problems; and
- Rule calls based on resource vulnerability that determine standards of performance for the rule call.

The field managers produce:

- Prescriptions with justification for each mapped sensitive unit.

The entire team produces the final watershed report and may develop a monitoring proposal for the watershed to be handed off to stakeholders in the watershed.

## Maximum Projected Time by Activity

*Analysis Type*

**L 1 Interim**

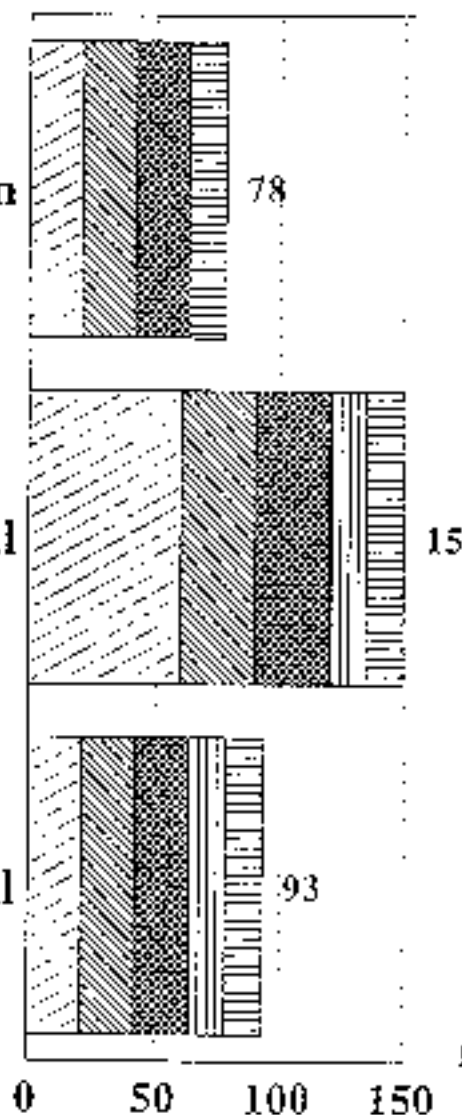
78

**L 2 Final**

150

**L 1 Final**

93



*Calendar Days*

**Activity**

- SEPA
- Circulate WA
- Prescriptions
- Alternatives
- Assessments

Level 1 with indeterminates are interim and only have SEPA comments.

Other Level 1 and all Level 2 are final.

The 15-day SEPA period is concurrent with the 30-day forest practices comment period.

*Additional time required to assemble data and evaluate SEPA comments.*

